RoboCup2005

Rescue Robot League Competition

Osaka, Japan

July 13 – 19, 2005

www.robocup2005.org

RoboCupRescue - Robot League Team

Mantes Explorer 2, France

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Abstract. For our second participation we have decided to design a new robotic structure from scratch, i.e. Mantes Explorer 2 is not an evolution of Mantes Explorer 1. Instead of wheeled robot, we choose to design a tracked robot which seems to be more suitable for climbing.

Introduction

This robot has been designed in the mechatronics department of the engineer school of the Versailles University (ISTY). The mechatronics department is closely linked to the Versailles Robotics Laboratory (LRV) which has some experience about robocup and mobile systems. Mantes Explorer 2 has been designed by engineering school students with the help and advice of researchers and technicians from the LRV.

As a consequence of our first participation's experience, we decided to design an entirely new mechanical and electronic structure. At the time of this report is prepared most of the mechanical design is achieved and assembly of the machine has started.

1. Team Members and Their Contributions

Pierre Blazevic is professor in University of Versailles, deputy director of the VRL and head of the mechatronics department of ISTY. His role in this project is to validate technical solution proposed by the students.
This robot is the project of 3 second year students.
They have been helped by a technician from LRV for electronic technologies and PCB routing, his name is Olivier Negro.
Renaud Aubin, an LRV PhD student has worked on Human-Robot interface and on mother board programming.

- **Team Leader:** Pierre BLAZEVIC
- **Mechanical design :** Fabrice HERAULT, Yann VERDIER
- **Electronic design :** Jérôme SALAÜN
- **microcontroller programming :** Fabrice HERAULT, Jérôme SALAÜN
- **Embedded computer design and programming**
- **Host computer design and programming**
- **Human-Robot GUI design**

  Renaud AUBIN
- **Help on electronic technologies and PCB routing** : Olivier NEGRO

2. Operator Station Set-up and Break-Down (10 minutes)

The operator station will only be a portable computer to which a joystick and a wireless access point will be connected, so it will be set-up and broken-down very quickly. We think that only one operator should be sufficient to control the robot but we have not decided yet. When the Human-Robot interface and the map generation method will be finished we will know how many operators are necessary.

3. Communications

We will use a wireless communication with following characteristics: 5.0 GHz – 802.11a as recommended. Last year a DLINK Access point has shown some difficulties to be used in the field. This year a NEC PA-WL/54TE, brought in Japan and used with success with some Japanese team will be onboard the robot.

Data to be transmitted to the robot:

- Motors control
- Camera parameter (luminosity, resolution)
- Video rate

Data to be received:

- Sensors data
- Images

4. Control Method and Human-Robot Interface

Our robot will be teleoperated. Some functions can be done automatically by the robot if the operator pushes a button. For example the operator can call a function which will prepare the robot to climb steps.
The operator will have to look attentively at the video feedback in order to locate victims and observe obstacles which could obstruct the robot way.
The graphical interface will display the video feedback oh the 2 cams and a synthesis of the embedded sensors.

Remote operation will use a PC notebook running under LINUX using a Joystick. Embedded PC is an EPIA M10000 mother board to which a wireless access point is connected. The embedded software will run under the LINUX. In our configuration we have installed LINUX on a flash disk.

- **Operator Station:**
  - type: laptop (Intel arch)
  - OS: Linux distribution based on debian
  - peripherals: wireless access point via Ethernet, joystick

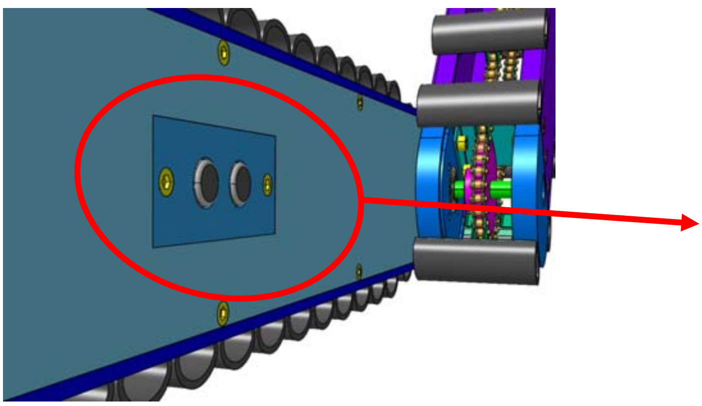
- **Embedded Computer:**
  - type: VIA EPIA M10000
  - OS: Linux distribution based on debian
  - data storage: flash disk
  - peripherals: wireless AP via Ethernet, USB webcam...

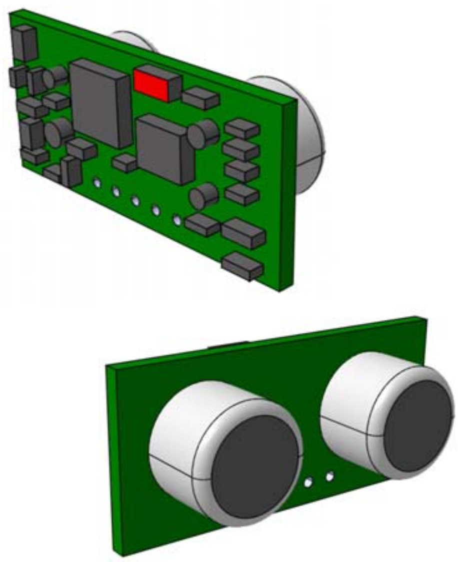
5. Map generation/printing

Motor position sensors coupled with a compass will be used as an odometer. This will allow knowing the position of the robot. Ultrasonic sensors will locate walls and obstacles. With these 3 sensor types we hope that we'll can generate automatically a map of the arena with its obstacles detected by ultrasonic sensors. The map generation algorithm has not been defined for the moment.

6. Sensors for Navigation and Localization

Ultrasonic sensors will be used to localize nearest obstacles.
A compass will give the robot orientation information to the operator.
A camera will be placed at the front of the robot in order to see the robot environment. A second cam which will be mounted at the top of the robot, at the end of a flexible pipe, will allow us to see the whole robot and its nearest rubbles.





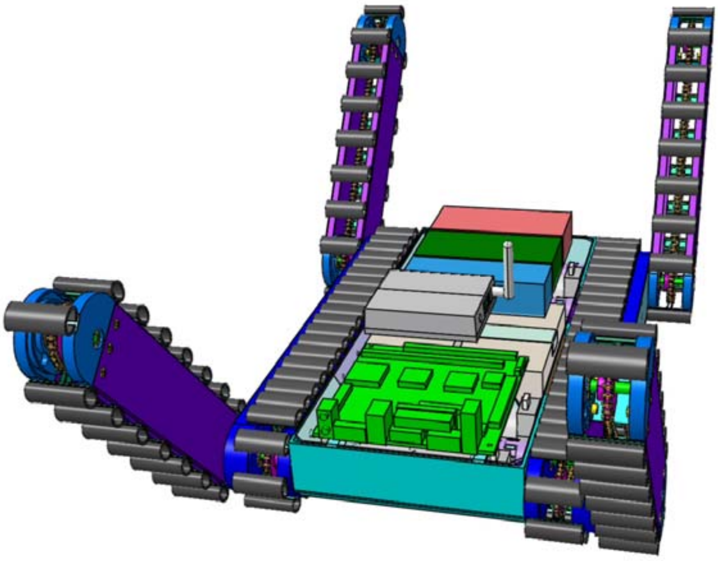
Integration of ultra sonic sensors

7. Sensors for Victim Identification

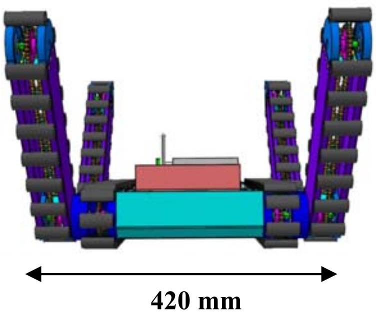
An infrared sensor is used to measure temperature radiation. With this measurement we will know if the victim's body is warm or not. A chemical sensor which indicates C02 concentration will give an indication about the victim respiration. Cameras will permit to see if the person still moves or is unconscious.
CO2 sensors is a FIGARO TGS4161
Infrared sensor is an IR Smartec DSSMTIR990X and will be mounted on the camera turret, in order to enable visual identification of any thermal signal.

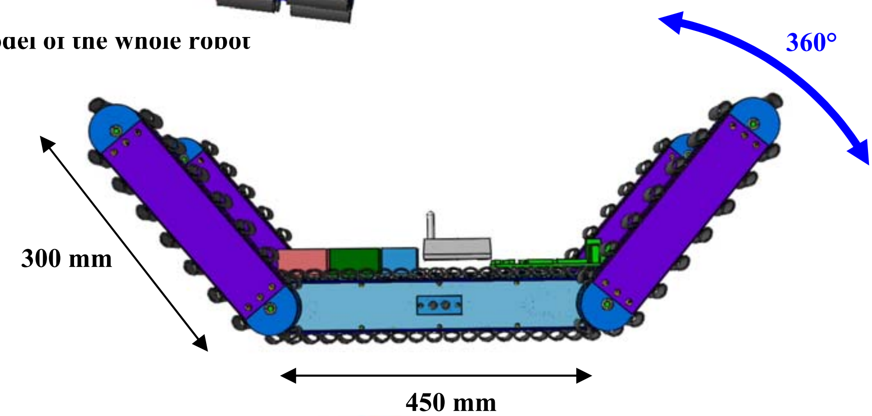
8. Robot Locomotion

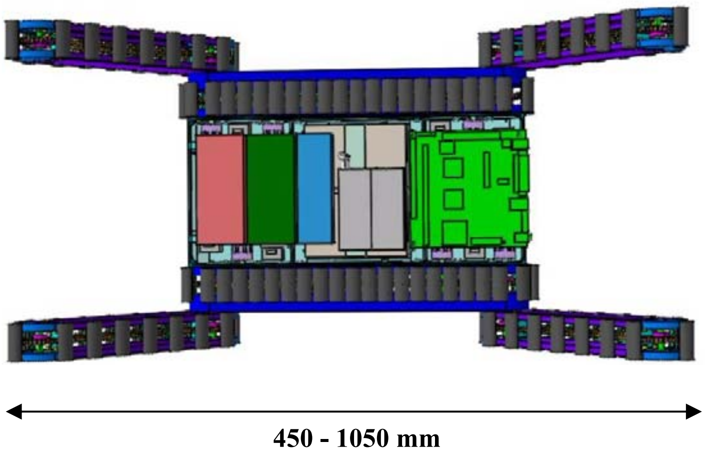
Last year we saw that tracked robot had very good performance for climbing obstacles. That's why we decided to use this way of locomotion. The robot is composed by two bands. The speed of each band can be controlled independently by a DC motor. 4 tracked arms are used to climb obstacles such as steps. We call these arms "flippers".



3D model of the whole robot



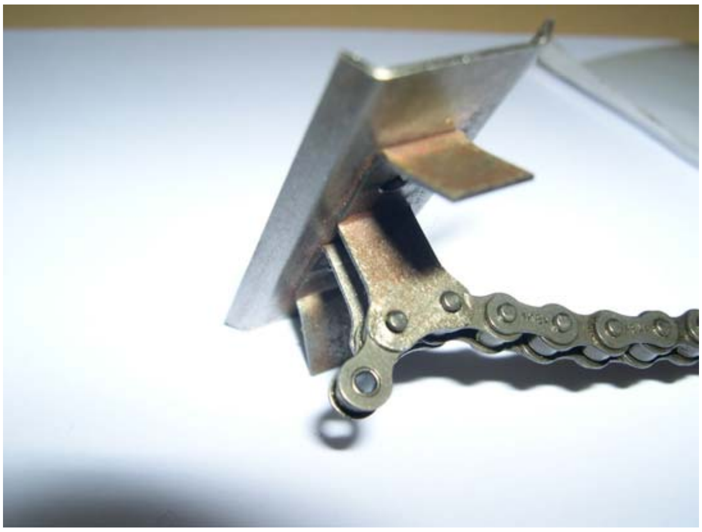




Parts of bicycle tires are used for the ground contact. This material allows a very good adherence.

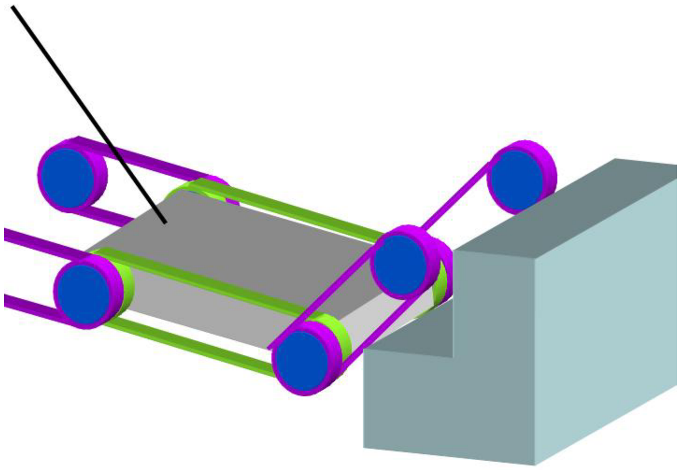
Part used for ground contact

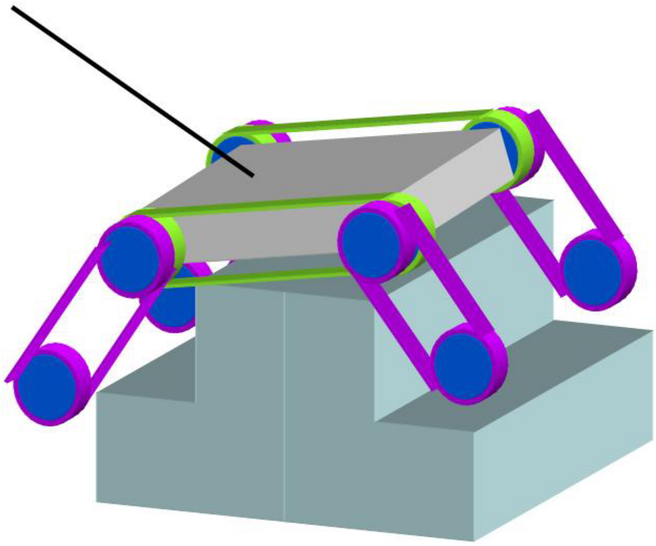
Parts used for ground contact are fixed on a chain which is motioned by a DC motor.



The chain with a tire support

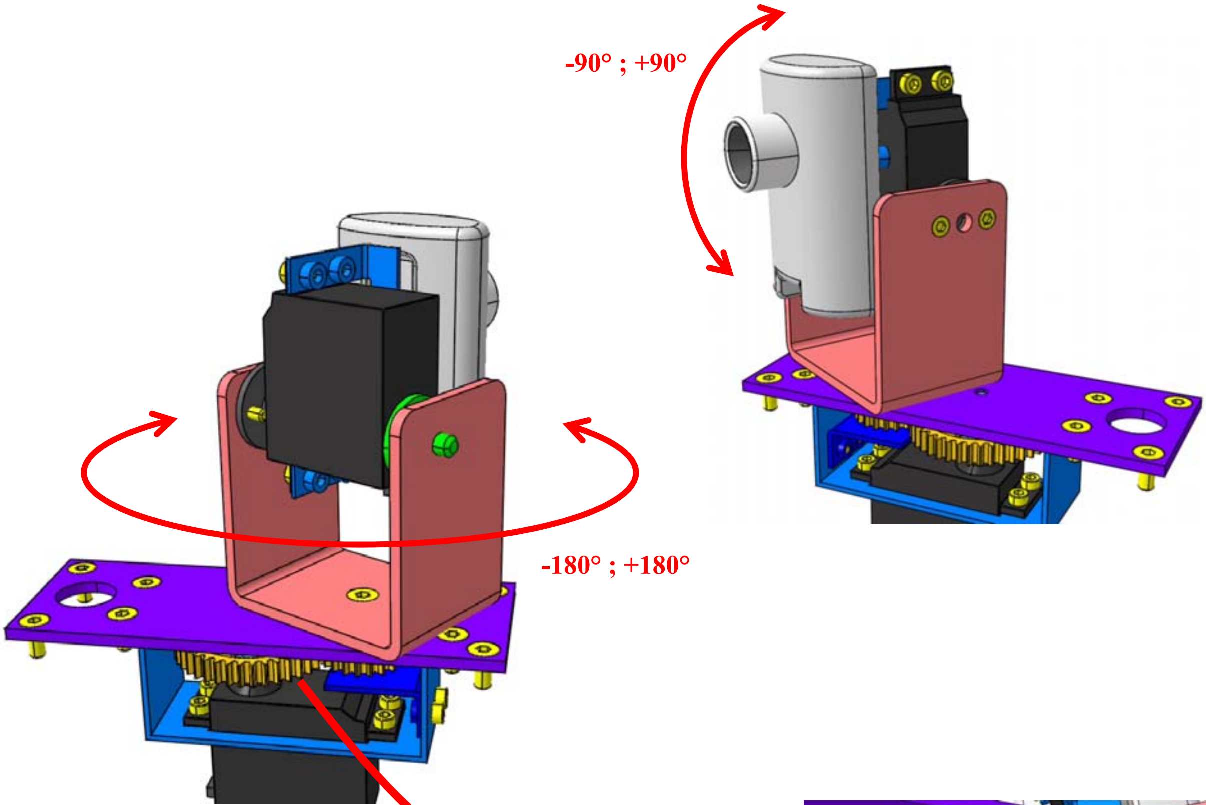
These 2 pictures are examples in which we can see that flippers are very useful for climbing obstacles. Our aim is to automate the flippers motion in order to ease operator tasks. For example the operator could click on a button which would prepare flippers position for climbing a step.

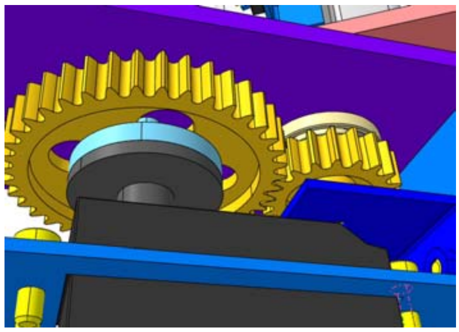




9. Other mechanism

The camera in the front of the robot will have 2 degrees have freedom motorized by 2 servomotors. Servomotors position will be controlled by a microcontroller. The specific mechanism described by the following pictures will allow these motions.





10. Team Training for Operation (Human Factors)

Team training is not yet solved as we cannot access to any rescue type environment. If no better solution is found training will be organized as follow:

Material and software training
Use of the software, test link, set-uprobot

Building map
This training will be done in a structured environment so we can check different map building techniques and find best operator in our team

Robot control
This training will outdoor in a non structured environment to validate our remote operation station, the embedded sensors and the vision

11. System Cost

sensors	400 €
sheet metal processing	2 000 €
wireless system	250 €
electronic boards	300 €
portable computer	1 500 €
traveling box	200 €
embedded PC	300 €
total	4 950 €